PAPER

EFFECTS OF TOMATO POMACE SUPPLEMENTATION ON CHEMICAL AND NUTRITIONAL PROPERTIES OF CRACKERS

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ABSTRACT

Tomato paste waste materials are rich in bioactive food components, but have a low economic value. In this study, the potential use of tomato pomace in crackers was studied. Wheat flour was partially (4%, 8%, 12%) substituted with dried tomato pomace meal. Tomato pomace addition caused a significant ($p<0.05$) increase in protein, ash, dietary fiber (soluble, insoluble, total), minerals (Mg, Ca, K, P, Mn, Zn, Fe), total phenolics, antioxidant capacity, Hunter *a* and *b* color values, but decrease in *L* value. Although the samples having 12% tomato pomace had lower scores, the crackers were liked statistically equally by the panelists.

Keywords: Cracker, tomato pomace, total phenolics, dietary fiber, minerals, sensory

1. INTRODUCTION

Tomato (*Lycopersicon esculentum L*) is the world's second largest vegetable crop (VALENCIA *et al*., 2002). Worldwide, about 37 million tons of tomatoes are processed in the industry (KESKIN, 2012). A large part of the world tomato crop is processed into tomato paste, which is used as an ingredient in many products such as soups, sauces, and ketchup (SANCHEZ *et al*., 2003). The problems of industrial wastes are becoming harder to solve, and much effort will be needed to develop the nutritional and industrial potential of by-products, waste and under-utilized agricultural products (AJAYI *et al*., 2006). Tomato industry generates large amounts of by-products, and these by-products representing 10-30% of total processed tomatoes contain tomato seeds, peels, pulp and cores (RAHMATNEJAD *et al*., 2009). Seeds and peels present in tomato pomace (TP) consist of the substances that are rich in nutritional value. It is underlined in some studies that they are rich in biologically active compounds, such as dietary fiber, protein, oil, mineral matters, phenolic compounds and carotenoids (EL-ADAWY and TAHA, 2001; SCHIEBER *et al*., 2001; SOGI *et al*., 2002; KNOBLICH *et al*., 2005; CALVO *et al*., 2008).

Crackers are popular snack foods in human diet (SEDEJ *et al*., 2011). They are dry, thin and crisp bakery products and the low level of moisture, decreased even further with baking, left no medium for mold growth (HAN *et al*., 2010). There are different types of crackers such as; saltiness cracker, soda cracker, sprayed cracker, cream cracker, savory cracker, matzos cracker, water cracker, Graham cracker, etc. (YONEYA and NIP, 2006). The basic ingredients in cracker production are wheat flour, fat (or shortening), salt, leavening agents (yeast, chemical leaveners, or combination), whey powder, sugar and/or glycose syrup (YONEYA and NIP, 2006; GUNDOGDU SERTAKAN, 2006). Crackers are usually produced with soft white flour (KWEON *et al*., 2014). But, the contents of some components in white flour, like amino acids (lysine, tryptophan) and dietary fiber that play an important role in nutrition, are low (ELGUN and ERTUGAY, 1995). Crackers could be an alternative food for the consumption of tomato pomace that is rich in biologically active compounds.

In the study, white wheat flour used in soda cracker production was substituted with tomato pomace meal to improve the nutritional and functional properties of crackers and it was aimed to determine the potential use of tomato paste waste material, usually utilized in animal feeding and rich in biologically active components, in human diet. The use of waste materials in human diet could also decrease environmental pollution problem

2. MATERIALS AND METHODS

2.1. Materials

Commercial wheat flour (Type 650), wheat starch, corn oil, sugar, salt and baking powder (sodium bicarbonate, sodium acid pyrophosphate) were purchased from local markets in Denizli, Turkey. Waste materials of tomato paste production were obtained from Honaz Paste Plant (Honaz, Denizli, Turkey).

2.2. Methods

2.2.1. Preparation of tomato pomace meals

Tomato pomace was dried in a cabinet dryer (Yücebaş Machine Analytical Equipment Industry, Izmir, Turkey). The dryer was consisted of a centrifugal fan to supply the airflow, an electric heater, and an electronic proportional controller (ENDA, EUC442, Istanbul, Turkey). The air velocity was kept constant at 0.2 m s^{-1} during drying at 60°C. The relative humidity of ambient air changed between 19 and 21%. After drying, pomaces were ground with a grinder (Toper TKS-16S, Izmir, Turkey) to a particle size of < 1000 μm.

2.2.2. Production of crackers

Soda crackers were prepared according to the procedure of HAN *et al*. (2010) with some modifications. Formulations presented in Table 1 were used to produce crackers. Crackers containing tomato pomace meals were prepared by substituting 4, 8 or 12% of flour in the formulae with dried tomato pomace. The preparation of crackers included steps of mixing of dry and liquid ingredients for 3-4 minutes to form a dough (KitchenAid, Artisan Series, Model 5KSM150, USA), resting of dough for 10 minutes, passing of dough through a set of smooth stainless steel rotating drums 3 times (KitchenAid, Artisan Series, Model 5KSM150, USA) by sheeting and laminating the dough, and cutting square shaped crackers from the dough sheet. Crackers were baked in an electric oven (Özköseoğlu, Istanbul, Turkey) at 200°C for 10 minutes. After baking, crackers were left in the oven for an additional 2 minutes with the heat off but with forced air circulation. This process simulated the drying and cooling stages of a tunnel-type commercial baking oven. Baked crackers were then removed from the oven and allowed to cool down to room temperature.

Table 1: Soda cracker formulations.

Ingredients (g)	Control	TP4[a]	TP8[b]	TP12[c]
Wheat flour	450.0	430.0	410.0	390.0
Dried tomato pomace meal	-	20.0	40.0	60.0
Wheat starch	50.0	50.0	50.0	50.0
Water	200.0	250.0	250.0	250.0
Corn oil	75.0	75.0	75.0	75.0
Sugar	17.5	17.5	17.5	17.5
Salt	5.5	5.5	5.5	5.5
Baking powder	5.0	5.0	5.0	5.0

[a]TP4: 4% of wheat flour was substituted with dried tomato pomace powder, [b]TP8: 8% of wheat flour was substituted with dried tomato pomace powder, [c]TP12: 12% of wheat flour was substituted with dried tomato pomace powder.

2.2.3. Analytical measurements

Total solids, ash, and oil contents of the samples were determined according to the methods of AOAC (1990). Crackers were analyzed for their total protein contents by a Dumatherm nitrogen-determination system run under the combustion method (Gerhardt Analytical Systems, Dumatherm, Germany) (ANONYMOUS, 2011).
Dietary fiber contents were determined with the fiber assay kit (Megazyme K-TDFR, Wicklow, Ireland) according to the Mes-Tris AOAC method 991.43 (1995) and AACC method 32-07 (1995). Samples were first suspended in the Mes-Tris buffer and then,

digested by heat-stable α-amylase, protease, and amyloglucosidase to remove starch and protein. Insoluble dietary fiber was recovered from the enzyme digestate after filtration. Soluble dietary fiber in the filtrate was precipitated with ethanol and filtered. All dietary fiber fractions collected were dried at 103±2°C for a night. Total dietary fiber content was calculated as the sum of insoluble and soluble dietary fiber contents. All dietary fiber contents were corrected for residual protein, ash, and blank.

Inductively coupled plasma optical emission spectrometer (ICP-OES, Perkin Elmer, Optima 8000, Massachusetts, USA) was used to determine the mineral elements (Mg, Ca, K, P, Mn, Zn and Fe) of wheat flour, tomato pomace and crackers. In the pretreatment stage, digestion of 1g sample was performed using a mixture of HNO_3:H_2O_2 (8:4) in a microwave oven (Milestone Start D, Sorisole, Italy) (GOPALANI *et al*., 2007; Anonymous, 2016). In the first step of digestion, the samples were digested for 15 min until reaching 110°C, and in the second step they were kept at this temperature for 15 min. The optimal operation conditions for ICP-OES analysis of mineral matters were as follows: RF power, 1450 W; plasma gas (Ar) flow rate, 15 L/min; auxiliary gas (Ar) flow rate, 0.2 L/min; nebulizer flow rate, 0.7 L/min; sample flow rate, 1.5 mL/min; delay time, 15s. Sensitive wavelengths for mineral identification were obtained from the tables provided by the manufacturer (BOSS and FREDEEN, 2004).

For the extraction of phenolics, crackers were mixed with 70% (v/v) methanol with a 1:10 (w/v) ratio and homogenized (IKA-Ultra Turrax, Staufen, Germany). Then the mixture was treated in an ultrasonic water bath (Elma E 60 H, New Jersey, USA) for 10 minutes and shaken in a mechanical orbital shaker (WiseShake SHO-1D, Wertheim, Germany) for 15 minutes. Finally, the liquid extract was separated from solids by centrifugation (26,000g for 20 minutes at 4°C, Hettich, Universal 30 RF, Massachusetts, USA). The supernatant was recovered and the extraction step was duplicated for the precipitate. The supernatants of the two steps were mixed and stored at -24°C until total phenolic content and antioxidant activity analyses.

Folin-Ciocalteu method (SINGLETON *et al*., 1999) was used to determine total phenolic content. 1 mL of extract was mixed with 5 mL of 1:10 (v/v) Folin-Ciocalteu reagent:water mixture for 5 minutes and 4 mL of 75g/L sodium carbonate (Na_2CO_3) was then added. After incubation at room temperature for 2 hours, the absorbance of the reaction mixture was measured by a spectrophotometer (T80 UV/VIS Spectrometer, PG Instruments Ltd., Leicestershire, United Kingdom) at 760 nm. Gallic acid (0–100mg/L) was used as a standard to produce the calibration curve and the total phenolic content of extracts was expressed in mg of gallic acid equivalents (GAE)/100 g dry matter of wheat flour, tomato pomace meal and crackers.

DPPH assay was used to determine the antioxidant activity of extracts (THAIPONG *et al*., 2006). The stock solution was prepared by dissolving 24 mg DPPH with 100mL methanol and then stored at -20°C until needed. The working solution was obtained by mixing 10mL stock solution with 45mL methanol to obtain an absorbance of 1.10± 0.02 units at 515 nm using the spectrophotometer. Cracker extracts (150 µL) were mixed with 2850 µL of the DPPH solution and allowed to react for 24 h in the dark. Then the absorbance was taken at 515 nm. The standard curve was linear between 25 and 800µM Trolox. Results were expressed in µM TE/100 g dry mass. Additional dilution was needed if the DPPH value measured was over the linear range of the standard curve.

2.2.4. Physical and sensory properties of crackers

Color values (Hunter L, a, b) of crackers were determined by a Hunter LabMini Scan XE model colorimeter (Reston,VA, USA) (ANONYMOUS, 1995).

In sensory evaluation, a panel of 48 subjects in the Department of Food Engineering (Pamukkale University, Denizli, Turkey) evaluated the sensory properties of soda crackers and assigned scores for color, smell, flavor, crispiness, and overall acceptability on a hedonic scale from 1 (dislike extremely) to 7 (like extremely). The panel consisted of students, staff and faculty members (30 females, 18 males), and 60% of the subjects were between 18 and 25, 27% between 26 to 40 years old, and 13% older than 40 years. The samples were labeled randomly with three-digit numerical codes. During the panel, subjects were instructed to rinse their mouths with water, and eat unsalted crackers before tasting each sample. The panel was performed in partitioned boots equipped with daylight.

2.2.5. Statistical analysis

"Minitab 13 Statistical Software" was used for the statistical analysis of data. ANOVA (one-way analysis of variance) with Tukey's multiple comparison test was performed to determine significant differences at α=0.05.

3. RESULTS AND DISCUSSION

Crude protein, crude oil, crude ash, soluble, insoluble and total dietary fiber contents, mineral matters (Mg, Ca, K, P, Mn, Zn, Fe) and total phenolic compounds contents, antioxidant activity values and color values of wheat flour and tomato pomace meal are given in Table 2. Results indicated that tomato pomace used in this study is a good source of crude protein, crude oil, dietary fiber, and minerals, and has higher total phenolic compounds and antioxidant capacity values than wheat flour. In the present work, soda cracker was supplemented with tomato pomace meal in order to enrich the nutritional status of the final product.

In previous studies, tomato pomace was reported to have a protein content of 16.27-19.65%, oil content of 5.85-10.75%, dietary fiber content of 54.79-59.03% and ash content of 3.472-4.046% (ALVARADO *et al*., 2001; DEL VALLE *et al*., 2006; ISIK, 2013). Our results were mostly similar to those reported in the literature. The small differences can be due to several factors including climate, geography, geochemistry, agricultural practices like fertilization and genetic composition (TOLEDO and BURLINGAME, 2006).

Tomato pomace powder had higher *a* and *b* values in color than wheat flour, which can be explained by higher carotenoid contents of tomato pomace, especially lycopene (SHARMA and LE MAGUER, 1996; SCHIEBER *et al*., 2001; KNOBLICH *ET AL*., 2005; SIKORA *et al*., 2008). Lycopene is an important carotenoid which gives red color to tomato, and lycopene content of tomato peel is about 3025 μg/100 g (SHARMA and LE MAGUER, 1996; SIKORA *et al*., 2008).

3.1. Effect of tomato pomace addition on the proximate chemical composition of crackers

Ash, crude protein, soluble, insoluble and total dietary fiber, and mineral contents of soda crackers increased significantly ($p < 0.05$) with tomato pomace powder addition (Table 3). The reason is most likely that tomato pomace meal, which substituted wheat flour in cracker production, had higher crude protein, dietary fiber, crude ash and mineral contents than wheat flour (Table 2).

Table 2: Chemical and nutritional properties of wheat flour and tomato pomace meal.

Parameter	Wheat flour[a]	Tomato pomace meal
Crude protein (%)	10.87	16.31
Crude oil (%)	1.66	5.38
Total dietary fiber (%)	2.89	59.94
Soluble dietary fiber (%)	1.39	4.91
Insoluble dietary fiber (%)	1.50	55.03
Crude ash (%)	0.480	3.492
Mg (ppm)	398.3	2850.6
Ca (ppm)	380.4	3625.5
K (ppm)	1950.4	24500.3
P (ppm)	1403.2	4625.1
Mn (ppm)	9.5	40.1
Zn (ppm)	12.5	41.5
Fe (ppm)	19.1	130.5
Total phenolic compounds (mg GAE/ 100g)	104.12	427.81
Total antioxidant activity (μmol TE/ 100g)	2.364	80.34
Hunter color values		
L	94.43	54.95
a	0.44	16.12
b	9.20	19.65

[a]All values are in dry basis.

A generous intake of dietary fiber may help to reduce risk for developing diseases such as coronary heart disease, stroke, hypertension, diabetes, obesity and certain gastrointestinal disorders such as constipation, diverticulitis and large bowel cancers (ANDERSON *et al*., 2016; MUDGIL and BARAK, 2013). Dietary fiber intake recommendations for adults generally fall in the range of 20 to 35 g/day or 10 to 13 g per 1,000 kcal energy intake (MARLETT *et al*., 2002). In this case, by the consumption of 100g of control, TP4, TP8 and TP12 crackers, an adult can take about 6.2%, 17.7%, 22.3% and 28.5% of his daily recommended dietary fiber intake, respectively. Crackers containing tomato pomace powder at different ratios provide significantly higher dietary fiber intakes than control cracker for the consumers.

Minerals are essential for a wide variety of metabolic and physiologic processes in human body. They are useful for many actions in the body like muscle contraction, normal heart rhythm, nerve impulse conduction, oxygen transport, oxidative phosphorylation, enzyme activation, immune functions, antioxidant activity, bone health, and acid base balance of the blood (WILLIAMS, 2005; SALDAMLı and SAĞLAM, 2007; LAKSHMI, 2014). An adequate daily amount of minerals is necessary for optimal functioning.

Table 3: Chemical and nutritional properties of crackers supplemented with various amounts of tomato pomace powder.

Parameter	C[a,b]	TP4	TP8	TP12
Crude protein (Nx5.7) (%)	7.35±0.16c	7.63±0.08b	7.80±0.01ab	7.82±0.04a
Crude oil (%)	16.50±1.15a	16.75±0.29a	17.62±0.88a	18.06±0.97a
Total dietary fiber (%)	1.86±0.29d	5.30±0.55c	6.68±0.43b	8.54±0.58a
Soluble dietary fiber (%)	1.02±0.49b	1.82±0.19ab	2.01±0.22a	2.50±0.55a
Insoluble dietary fiber (%)	0.84±0.21d	3.48±0.41c	4.67±0.30b	6.04±0.42a
Crude ash (%)	1.269±0.192b	1.520±0.151ab	1.554± 0.109ab	1.693±0.120a
Mg (ppm)	185.0±39.6b	283.9±54.6ab	306.1±21.4ab	400.7±114.7a
Ca (ppm)	213.9±15.9c	356.2±15.0b	493.9±8.3a	569.9±89.4a
K (ppm)	1491.1±109.2d	2108.9±41.9c	2738.7±140.5b	3090.0±132.7a
P (ppm)	1871.8±164.6b	2123.1±157.1ab	2250.2±252.8ab	2314.2±147.2a
Mn (ppm)	9.7±1.7b	12.3±2.4b	14.4±1.6ab	23.0±8.5a
Zn (ppm)	8.8±2.6b	11.0±3.1b	17.8±2.5a	22.6±2.9a
Fe (ppm)	8.9±2.4c	12.6±2.5bc	15.8±1.0b	22.1±4.3a
Total phenolic compounds (mg GAE/ 100g)	52.52±6.50d	68.59±3.67c	104.402±6.69b	127.585±9.26a
Total antioxidant activity (μmol TE/ 100g)	7.20±0.97c	7.67±2.12c	13.23±2.11b	18.11±1.59a
Hunter color values				
L	68.55±1.82a	63.04±0.26b	57.17±0.40c	53.06±1.14d
a	4.15±1.06d	7.28±0.27c	9.67±0.20b	10.87±0.20a
b	21.10±0.90b	22.39±0.15a	23.08±0.12a	22.82±0.45a

[a]All values are in dry basis;

[b] Different letters within the row across the table show significant differences at α=0.05.

In this study, addition of tomato pomace meal to cracker formulation caused increases ($p<0.05$) in mineral contents (Mg, Ca, K, P, Mn, Zn and Fe). Substitution of wheat flour by tomato pomace powder in crackers at a level of 12% increased mineral levels in crackers between a ratio of 23.6% (for P) and 166.4% (for Ca). According to our calculations, an adult can take about 15.45% of K, 5.70% of Ca, 10.83% of Mg, 28.93% of P, all of Mn, 22.60% of Zn and 24.55% of Fe daily requirements by the consumption of 100g of TP12 cracker. On the other hand, he or she can take about 7.45% of K, 2.14% of Ca, 5.00% of Mg, 23.39% of P, 44.09% of Mn, 8.80% of Zn and 9.88% of Fe daily requirements by the consumption of 100g of control cracker (BAYSAL, 2007; SALDAMLI and SAĞLAM, 2007).

3.2. Effect of tomato pomace addition on total phenolic compounds and total antioxidant ativity values in crackers

The results in Table 3 show that the substitution of wheat flour by tomato pomace meal powder increased the total phenolics contents and antioxidant activity values of crackers. Cracker samples having all levels of tomato pomace powder had significantly ($p<0.05$)

higher total phenolics contents than control crackers. Crackers having 8 and 12% of tomato pomace powder had significantly ($p<0.05$) higher antioxidant activity values than control crackers. The reason for these results is most likely that the tomato pomace meal had a higher total phenolics content and antioxidant activity value than wheat flour (Table 2). Indeed, tomato skins and seeds, which are the main portion of tomato pomace, include polyphenolic compounds primarily the quercetin, rutin, chlorogenic acid, naringenin and kaempferol (VERHOEYEN *et al*., 2002; SIKORA *et al*., 2008; NAVARRO-GONZALEZ *et al*., 2011; KAMILOGLU *et al*., 2013). Additionally, tomato skin, which presents the important portion of tomato pomace, is a rich source of lycopene (SHARMA and LE MAGUER, 1996; SCHIEBER *et al*., 2001; KNOBLICH *et al*., 2005) and lycopene is a carotenoid which has the highest antioxidant activity in common carotenoids (ASICIOGLU, 2005; KAMILOGLU *et al*., 2013). Lycopene is the most abundant carotenoid in tomatoes, accounting about 83% of the total pigments present, and is responsible for the bright red color of tomatoes (KAMILOGLU *et al*., 2014). Tomato skin and seeds also contain other components which have high antioxidant activity primarily β-carotene as a carotenoid and vitamin C (KNOBLICH *et al*., 2005; SIKORA *et al*., 2008; STRATI and OREOPOULOU, 2011).

3.3. Effect of tomato pomace addition on physical and sensory properties of crackers

Addition of tomato pomace powder had a decreasing effect on L color value, and increasing effect on a and b color values (Table 2). These are mostly due to their higher a and b, and lower L values of tomato pomace than wheat flour (Table 2). These higher a and b color values of TP4 and TP8 were also liked more by the panelists in sensory evaluation (Table 4).

Sensory evaluation results of soda crackers are presented in Table 4. Control crackers and crackers substituted with tomato pomace received similar ($p>0.05$) scores in color, smell, flavor, crispiness and overall acceptability. Although increasing the substitution level of tomato pomace powder to 12% caused some reductions in the scores, this decrease was statistically insignificant.

In the sensory evaluation, a number of panelists reported that TP12 crackers had a little bitterness taste (data not shown). It's thought that this was most likely from a bitter component, named TFI, presented in tomato seeds. TFI is a furostanol saponin and it's chemical structure was established as 5α-furostane-3β,22,26-triol-3-[*O*-β-D-glucopyranosyl (1→2)-β-D-glucopyranosyl (1→4)-β-D-galactopyranoside] 26-O-β-D-glucopyranoside by SATO and SAKAMURA (1973).

Table 4: Results of sensory evaluation.

Cracker sample	Color	Smell	Flavor	Crispiness	Overall Acceptability
Control	4.48±0.60	4.88±0.48	4.71±0.25	4.81±0.24	4.88±0.24
TP4	5.17±0.23	4.92±0.29	4.71±0.48	4.65±0.30	4.92±0.16
TP8	4.79±0.91	4.77±0.58	4.50±0.57	4.73±0.27	4.69±0.24
TP12	4.15±0.59	4.77±0.31	4.38±0.25	4.56±0.12	4.54±0.53

4. CONCLUSIONS

Byproducts of tomato processing industries have been known as a good source of biologically active food components, but have a low economical value. In this research, potential use of tomato pomace powder in human diet was studied and successful results were obtained. Tomato pomace powder addition increased the crude protein, soluble, insoluble and total dietary fibers, mineral, total phenolic contents and total antioxidant capacity of crackers. Crackers having tomato pomace powder had higher a and b color values than control, and colors of TP4 and TP8 had higher scores in sensory analysis in spite of the difference with others was insignificant ($p>0.05$). Panelists liked crackers equally in terms of color, smell, flavor, crispiness, and overall acceptability. But results of sensory evaluation indicated that substitution of wheat flour higher than 12% by tomato pomace powder in the production of soda crackers is not recommended.

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REFERENCES

AACC. 1995. Determination of Soluble, Insoluble and Total Dietary Fiber in Foods and Food Products (Method 32-07). Approved Methods of the American Association of Cereal Chemists. 9th Ed. American Association of Cereal Chemists, Inc., St. Paul, MN.

Ajayi I.A., Oderinde R.A., Kajogbola D.O. and Uponi J.I. 2006. Oil content and fatty acid composition of some underutilized legumes from Nigeria. Food Chem. 99(1):115.

Alvarado A., Pacheco-Delahaye E. and Hevia P. 2001. Value of a tomato byproduct as a source of dietary fiber in rats. Plant Food Hum. Nutr. 56:335.

Anderson J.W., Baird P., Davis Jr.R.H., Ferreri S., Knudtson M., Koraym A., Waters V. and Williams C.L. 2009. Health benefits of dietary fiber. Nutr Rev. 67(4):188-205.

Anonymous 1995. "The Manual of Hunter-Lab Mini Scan XE Colorimeter" Virginia: HunterLab Cooperation, U.S.A.
Anonymous 2011. "Handbook of Gerhardt Dumatherm Instruction Manual" C.Gerhardt GmbH & Co. KG.

Anonymous 2016. Microwave Sample Preparation for AA and ICP. http://allchemy.iq.usp.br/agregando/wpa/Palestra5.pdf

AOAC 1990. Official Methods of Analysis. 15th Ed. Association of Official Analytical Chemists, Washington, DC.

AOAC 1995. Total, Insoluble and Soluble Dietary Fiber in Food-Enzymatic-Gravimetric Method (Method 991.43) MES-TRIS Buffer. Official Methods of Analysis. 16th Ed. AOAC International, Gaithersburg, MD.

Aşıcıoğlu Y.T. 2005. Effect Of Lycopene On Chronic Alcoholic Liver Injury In Rats (in Turkish). PhD Thesis, Republic of Turkey, The Ministry Of Health, Şişli Etfal Teaching Hospital, Department of Biochemistry and Clinical Biochemistry, İstanbul.

Baysal A. 2007. Nutrition. 11th Ed. p. 111-151. Hatipoğlu Publications: 93, Ankara, Turkey.

Boss C.B. and Fredeen K.J. 2004. Concepts, Instrumentation and Techniques in Inductively Coupled Plasma Optical Emission Spectrometry, 3rd ed. Perkin Elmer Inc., USA.

Calvo M. M., Garcia M. L. and Selgas M. D. 2008. Dry fermented sausages enriched with lycopene from tomato peel. Meat Sci. 80:167.

Del Valle M., Camara M. and Torija M.A.E. 2003. Effect of pomace addition on tomato paste quality. VIII International Symposium on the Processing Tomato, B. Bieche and X. Branthome (Ed.), Istanbul, Turkey.

El-Adawy T. A. and Taha K.M. 2001. Characteristics and composition of different seed oils and flours. Food Chem. 74:47.

Elgün A. and Ertugay Z. 1995. Cereal Processing Technology (in Turkish). Publication No. 718, Atatürk University, Erzurum, Turkey.

Gopalani M., Shahare M., Ramteke D.S. and Wate S.R. 2007. Heavy Metal Content of Potato Chips and Biscuits from Nagpur City, India. Bull Environ Contam Toxicol. 79:384.

Gündoğdu Sertakan S. 2006. Posibilities of using Triticale flour at producing biscuit and cracker (in Turkish). PhD Thesis, Trakya University, Institude of Science, Edirne, Turkey.

Han J., Janz J.A.M. and Gerlat M. 2010. Development of gluten-free cracker snacks using pulse flours and fractions. Food Res. Int. 43:627.

Işık F. 2013. Use of Paste Waste Materials in Tarhana Production (in Turkish). PhD Thesis, Pamukkale University, Institude of Science, Denizli, Turkey.

Kamiloglu S., Boyacioglu D. and Capanoglu E. 2013. The effect of food processing on bioavailability of tomato antioxidants. J. Berry Res. 3:65.

Kamiloglu S., Demirci M., Selen S., Toydemir G., Boyacioglu D. and Capanoglu E. 2014. Home processing of tomatoes (Solanum lycopersicum): effects on in vitro bioaccessibility of total lycopene, phenolics, flavonoids, and antioxidant capacity. J. Sci. Food Agr. 94:2225.

Keskin G. 2012. Tomato and Tomato Paste 2011/2012 status and forecast (in Turkish). Publication No: 201, TEPGE, Ankara, Turkey.

Knoblich M., Anderson B. and Latshaw D. 2005. Analyses of tomato peel and seed byproducts and their use as a source of carotenoids. J. Sci. Food Agr. 85:1166.

Kweon M., Slade L., Levine H. and Gannon D. 2014. Cookie- Versus Cracker-Baking-What's the Difference? Flour Functionality Requirements Explored by SRC and Alveography. Crit. Rev. Food Sci. 54:115.

Lakshmi V. 2014. Calcium - A Vital Foundation Mineral for a Healthy Body. IJSER, 2(1):1.

Marlett J.A., McBurney M.I. and Slavin, J.L. 2002. Position of the American Dietetic Association: Health implications of dietary fiber. J. Am. Diet. Assoc. 102(7):993.

Mudgil D. and Barak S. 2013. Composition, properties and health benefits of indigestible carbohydrate polymers as dietary fiber: A review. Int. J. Biol. Macromol. 61:1-6.

Navarro-Gonzales I., Garcia-Valverde V., Garcia-Alonso J. and Periago M.J. 2011. Chemical profile, functional and antioxidant properties of tomato peel fiber. Food Res. Int. 44:1528.

Rahmatnejad E., Bojarpour M., Mirzadeh Kh., Chaji M. and Mohammadabadi T. 2009. The effects of different levels of dried tomato pomace on broilers chicken hematological indices. J. Anim. Vet. Adv. 8(10), 1989.

Saldamlı İ. and Sağlam F. 2007. Vitamins and Minerals. Ch. 6. In "Food Chemistry" 3rd ed. İ. Saldamlı (Ed), p. 365-423. Hacettepe University Publications, Ankara, Turkey.

Sanchez M.C., Valencia C., Ciruelos A., Latorre A. and Gallegos C. 2003. Rheological properties of tomato paste: influence of the addition of tomato slurry. J Food Sci. 68(2):551.

Sato H. and Sakamura S. 1973. A bitter principle of tomato seeds. Agr Biol Chem 37(2):225-231.

Schieber A., Stintzing F. C. and Carle R. 2001. By-products of plant food processing as a source of functional compounds-recent developments. Trends Food Sci. Tech. 12:401.

Sedej I., Sakac M., Mandic A., Misan A., Pestoric M., Simurina O. and Canadanovic-Brunet J. 2011. Quality assesment of gluten-free crackers based on buckwheat flour. Food Sci. Technol. 44:694.

Sharma S.K. and Le Maguer M. 1996. Kinetics of lycopene degradation in tomato pulp solids under different processing and storage conditions. Food Res. Int. 29(3-4):309.

Sikora E., Cieslik E. and Topolska K. 2008. The sources of natural antioxidants. Acta Sci. Pol. Technol. Aliment. 7(1):5.

Singleton V.L., Orthofer R. and Lamuela-Raventos R.M. 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu Reagent. Methods Enzymol. 299:152.

Sogi D.S., Arora M.S., Garg S.K. and Bawa A.S. 2002. Fractionation and electrophoresis of tomato waste seed proteins. Food Chem. 76:449.

Strati I. F. and Oreopoulou V. 2011. Effect of extraction parameters on the carotenoid recovery from tomato waste. Int. J. Food Sci. Tech. 46:23.

Thaipong K., Boonprakob U., Crosby K., Cisneros-Zevallos L. and Byrne D.H. 2006. Comparison of ABTS, DPPH, FRAP, and ORAC assays for estimating antioxidant activity from Guava fruit extracts. J. Food Compos. Anal. 19:669.

Toledo I. and Burlingame B. 2006. Biodiversity and nutrition: A common path toward global food security and sustainable development. J. Food Compos. Anal. 19:477.

Valencia C., Sánchez M.C., Ciruelos A., Latorre A., Franco J.M. and Gallegos C. 2002. Linear viscoelasticity of tomato sauce products: influence of previous tomato paste processing. Eur. Food Res. Technol. 214:394.

Verhoeyen M.E., Bovy A., Collins G., Muir S., Robinson S., de Vos C.H.R. and Colliver S. 2002. Increasing antioxidant levels in tomatoes through modification of the flavonoid biosynthetic pathway. J. Exp. Bot. 53(377):2099.

Williams M.H. (2005). Dietary supplements and sports performance: minerals. J. Int. Soc. Sports Nutr. 2(1), 43.

Yoneya T. ve Nip W.-K. 2006. Cracker Manufacture. Ch. 23. In: Bakery Products, Science and Technology. Y.H. Hui (Ed.), p. 411. Blackwell Publishing, Iowa 50014, USA.

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